UKube-1

UKube Program, its Payloads & Enabling Technologies

Steve Greenland

With thanks to all those involved -
UK Space Agency
Bright Ascension
EADS Astrium
AMSAT-UK
University of Strathclyde
Open University
University of Bath
UKSEDS
RALSpace
University of Dundee
Steepest Ascent
Cape Peninsula University of Technology
Commercial Space Technologies
SciSys
Knowledge Transfer Partnerships
Technology Strategy Board
Gomspace / ISIS / Pumpkin
Company timeline

- **2005**: Clyde Space formed late 2005
- **2006**: First OTS product (CubeSat EPS)
- **2007**: Bespoke modular power systems
- **2008**: First website to purchase space OTS
- **2009**: First flight heritage (ITUpsAT1)
- **2010**: Clyde Space CubeSat platform
- **2011**: ESA / ISO Quality Processes

- **2005**
  - First bespoke solar panel sales
- **2006**
  - First hi-rel variant product
- **2007**
  - Expanded to current facilities
- **2008**
  - OTS product range expanded beyond power subsystem
- **2009**
  - > TO 1.5mGBP
  - > 20 employees
  - > 200 CubeSat EPS

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UKube-1 requirements

• Five core mission objectives:
  – UKube-1 shall demonstrate new UK space technology.
  – UKube-1 shall demonstrate the capability of useful science to be performed within a CubeSat sized spacecraft.
  – UKube-1 shall demonstrate industry and university based training in spacecraft development.
  – UKube-1 shall demonstrate education and outreach in STEM subjects.
  – UKube-1 shall demonstrate Payload Kick-Off to flight qualified spacecraft in less than 12 months.

• Defined such that the significant parts can be met before reaching the launch pad
Why Clyde Space involvement?

- Attitude control
- Telemetry & switching
- Electric power system
- Batteries
- Modular interface concepts
- Solar arrays
- Structures
Program constraints

- UKube-1 heavily constrained by resources
  - personnel
  - timescales
- Free launch is the shared objectives for all parties
- Design part-driven by coalition of the willing
  - balanced by Astrium
- In March 2011, 4 payloads were selected from 22 proposals
- From July 2011, program organisation has changed with CSL taking on management responsibility
• Launch early 2013 Soyuz Fregat
C3D Imaging

- CMOS radiation damage monitoring
  - Total ionising
  - Single event
- Narrow and wide field imaging
- Onboard image processing
  - Histogramic image rejection
  - Thumnailling and compression
- Technology demonstration of CMOS for future ESA missions, e.g. JUICE
- Topside Ionospheric Occultation Assisted Tomography
- L1/2 space-grade GPS receiver
- Interface with ADCS for orbit positioning
• Space radiation based random number generation
• Applicability to patents for telecommunications
• EADS Astrium application of non-space grade SRAM based FPGAs
• Only outstanding payload awaiting integration with FlatSat

• A pocket satellite
  – OpenSpace365 - Arduino
  – Orbitview (popout camera)
  – SuperLab - superconductors
  – SuperSprite – satellite on a chip with a UHF downlink
Mission Interface Computer

- Supports asymmetric redundant architecture
- FPGA-based primary processor
- Radiation tolerant design
  - 2 MB SRAM
  - 2 GB NAND FLASH
- Looking for partners for further development
FUNCube Transceiver

- AMSAT-UK transceiver
- Meets UKube-1 education and outreach objectives
- FUNcube dongle allows satellite to be received
- Backdoor transceiver
• Redundant thermal knife deployment
• Longitudinal and lateral hinge designs
• Support designs for > 35 W instantaneous power
• Solar arrays feature integrated sun sensors
Active Magnetic Attitude Control

• FPGA based design with embedded control modes
  – Magnetic and inertial sensors
  – Magnetorquer actuation
  – Coarse sun sensors
  – Interface to TOPCAT GPS

• Future compatibility
  – High performance computing
  – 3-axis reaction wheels
S-band Transmitter

- High data rate transmitter
  - < 2 Mbps
  - Tx power 21 dBm to 30 dBm
  - 2400 – 2450 MHz in 500 kHz
  - SNR of 20 dB (min)
  - Spurious responses < -30 dBc
  - Open Network Encoding
• Developed with Bright Ascension
• freeRTOS-based
• CCSDS compatible with modified PUS
• Onboard operations scheduler
• File based data transfers
MEGSE Developments

- Payload interface emulator
- FlatSat board and peripheries
- Integration & environmental test jig
Distributed concurrent development

- Interface between platform & payload managed through interface emulator
  - Facilitate concurrent development of platform & payload
  - Demonstration & verification of key requirements
Developments for future UKube missions?

- Plasma pulse thrusters
  - ESA ITI
- Deorbit (solar) sail
  - UKSA / TSB
- ADCS testbed
  - UKSA / TSB
- Mission design tools
  - SFTC (iCASE)
- Inter-satellite link
  - industry sponsored
questions?

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